

**T E C H N I C A L B R I E F****Chlorine Inactivation of Bacterial Bioterrorism Agents****Background**

EPA's National Homeland Security Research Center (NHSRC), Water Infrastructure Protection Division (WIPD), headquartered in Cincinnati, Ohio, is responsible for protecting drinking water systems and sources. To carry out these responsibilities, the NHSRC, in collaboration with the Centers for Disease Control and Prevention (CDC), conducted research on the ability of chlorination to inactivate bacterial agents in drinking water.

Research

CDC and NHSRC studied the effectiveness of chlorine in drinking water, that is, "free available chlorine" (FAC), on the inactivation of vegetative and spore forms of bacterial bioterrorism agents. This study involved select strains of six bacterial species —

Brucella melitensis, *Brucella suis*, *Burkholderia mallei*, *Burkholderia pseudomallei*, *Francisella tularensis*, *Yersinia pestis* — and spores of *Bacillus anthracis* Ames and *Bacillus anthracis* Sterne.



During this study, researchers exposed triplicates for each organism for 1, 5, and 10 minutes, using a chlorine demand-free buffer and maintaining the temperature at 5 and 25 °C. Researchers monitored FAC and total chlorine levels during the experiments and reported the results as CT values; "C" is the concentration of chlorine in milligram/liters (mg/L), and "T" is exposure time in minutes. Water utilities use CT values to calculate microbial inactivation and to evaluate the effectiveness of water treatment systems.

Results and Conclusions

Results of this study indicate that under laboratory conditions at 1, 5, and 10 minutes, with a pH of 7.0, and at temperatures of 5 and 25 °C, the vegetative cells, with the exception of *Francisella tularensis*, were inactivated by three orders of magnitude. Under these same conditions, within 10 minutes, *Francisella tularensis* inactivation occurred at two orders of magnitude. For the *Bacillus anthracis* spores, at the same pH and temperature, inactivation required higher FAC concentrations and longer exposure times.

The researchers applied their findings to a 1992 survey of water utilities conducted by the Water Quality Division Disinfection Committee and published in the *Journal of American Water Works Association*. This survey indicated that when chlorine was used for water treatment, its median residual level was approximately 1.1 mg/L. This same survey also provides a median contact time of 45 minutes for chlorine in water treatment, with the time beginning when treatment starts and continuing to the first access point in the distribution system. Using the median levels and contact times from the 1992 study,

(more)

the CDC and NHSRC researchers concluded that under these conditions the vegetative cells (including *F. tularensis*) and bacterial spores, with the exception of the *Bacillus anthracis* spores, would be inactivated by more than three orders of magnitude. Researchers also concluded that inactivation of the *Bacillus anthracis* spores studied did not occur under these median conditions and that additional treatment would be required.

For more information, visit the NHSRC Web site at www.epa.gov/nhsrc.

Technical Contact: Eugene Rice (513) 569-7204, rice.eugene@epa.gov

Kathy Nickel (513) 569-7955, nickel.kathy@epa.gov